APPENDIX B

INTELLIGENT TRANSPORTATION SYSTEMS

1.0 INTRODUCTION AND OVERVIEW

Intelligent Transportation Systems (ITS) is a term used to describe projects which apply advanced technologies and communication systems to distribute and collect information to improve the efficiency and capacity of existing transportation systems. The growth and interest in ITS applications in the transportation industry have been significant in the past several years, as transportation system users and operators have an increased expectation for real-time systems information. The visitor experience and the comfort level with unfamiliar settings can be greatly enhanced with the provision of remote and on-site information about the transportation systems that the visitor may encounter. Appropriate and timely information can provide the visitor with the information necessary to successfully navigate to/from and within the natural environment of federal lands, including the following: parking, roadway systems, transit services, and trail systems.

This document first describes the functional areas of ITS as defined by *The Strategic Plan for IVHS [ITS] America*. Subsequently, this document focuses on the specific applications of ITS most relevant to group transportation systems found in or being considered for application on federally-managed lands. Section 3.0 discusses ITS vehicle technologies applicable to federal lands. Section 4.0 discusses ITS smart traveler technologies applicable to federal lands.

2.0 FUNCTIONAL AREAS OF INTELLIGENT TRANSPORTATION SYSTEMS

Several technologies are utilized in Intelligent Transportation Systems, including various types of computer hardware and software, and communication systems. Seven functional areas are briefly described below. Many of these functional areas apply the same technologies in different ways.

2.1 Advanced Traffic Management Systems (ATMS)

Advanced Traffic Management Systems are primarily aimed at improving vehicular flows on highways, arterial roads, and other streets. These systems typically use a combination of technologies that count, measure speed, and/or categorize motor vehicles to provide information to computers that control and adjust signal systems. Examples of this include the following:

- Traffic signals that adjust their timing to the flow of vehicles through an intersection,
- Freeway ramp metering systems that improve the flow of vehicles onto congested highways, and
- Speed detection and video surveillance of roadways that improves incident response.

2.2 Advanced Traveler Information Systems (ATIS)

Advanced Traveler Information Systems are aimed at providing users of the transportation system with more information with which to make decisions about route choices, estimate travel times, and avoid congestion. Most ATIS technologies are also aimed at the motor vehicle operator. Similar technologies, applied in a different way, are discussed below in reference to public transit. This broad category of applied technology includes the following:

- In-vehicle navigation systems (i.e. on-board computer maps) which can tell the drivers where they are and how to get to a destination,
- Variable message signs that provide information about congestion from traffic, and tell drivers which lanes to use or avoid, or provide alternate route information in case of road closures, and
- Terminals that could provide a color-coded network map showing congestion levels on area highways (a.k.a. congestion index).

2.3 Advanced Vehicle Control Systems (AVCS)

Advanced Vehicle Control Systems are aimed at increasing the safety and efficiency of vehicle operations. Using a combination of on-board computers and sensors and/or in-pavement markers, vehicles can be enhanced to do the following:

- Provide warnings to drivers to help drivers react to and avoid potential collisions.
- Initiate pre-crash restraint deployment of on-board vehicle systems.
- Operate on "autopilot," and reduce the spacing between vehicles on the highway while maintaining high safety levels.

With less spacing between vehicles, the facility capacity can be increased. Applied to other modes of travel, AVCS provides the capabilities to have fully-automated bus and tram shuttle systems.

2.5 Commercial Vehicle Operations (CVO)

ITS in commercial vehicle operations (trucking) applications applies Global Positioning Systems (GPS – uses satellites to locate vehicles) and other technologies primarily to increase the efficiency of freight movement and fleet management. Examples of this application include:

- Weigh-in-motion which allows trucks to transport and deliver goods, pay their share of roadway taxes, without needing to stop at a weigh station.
- Scanning technologies (lasers) are being used on roads and facilities with tolls to allow vehicles to pass through tollgates without stopping.
- GPS are used to locate and track the progress of deliveries.

2.6 Advanced Rural Transportation System (ARTS)

ARTS technologies provide information about remote road and other transportation systems. Examples include automated road and weather conditions reporting and directional information.

2.7 Advanced Public Transportation Systems (APTS)

APTS technologies can help improve transit and ridesharing services. By using GPS, wireless communication systems, and other devices, passengers are able to get more information about when a bus or carpool will arrive, know where a vehicle is along its route, and purchase a single card or pass that make transfers seamless and automatic. Operators and administrators of these systems are provided better quality information about who is using the services, when, and how.

3.0 ITS VEHICLE TECHNOLOGIES APPLICABLE TO FEDERALLY-MANAGED LANDS

This section focuses on the specific ITS applications most relevant to vehicles found in or being considered for application on federally-managed lands. The "smart vehicle" incorporates vehicle-based technologies to achieve more effective fleet scheduling and utilization.

The degree of technological sophistication needed to implement smart vehicle systems varies depending upon the type of service provided. Fixed route systems can function effectively in natural settings with minimal advanced technologies. Such technologies are currently in use in the public and private sectors.

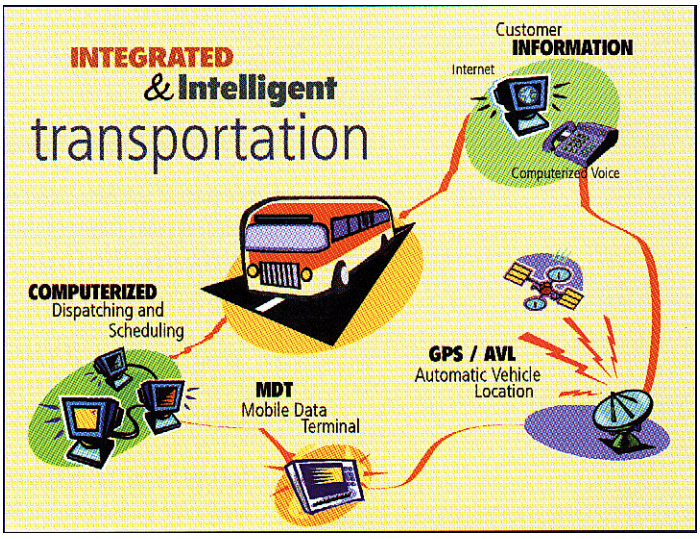
The following smart vehicle technologies are discussed in turn and their relationship is depicted in Figure B-1.

- Communication Systems.
- Annunciators (Talking Buses).
- Computerized Dispatching/Scheduling/Ridematching Systems.
- Automatic Passenger Counters.
- Automated Vehicle Location Systems.

3.1 Communications Systems

ITS communication systems for vehicles serve many purposes. Vehicles (buses) outfitted with the appropriate technology are able to communicate with traffic signals and gate mechanisms to receive priority over other vehicles or gain access to some roads restricted for use by transit vehicles only. Vehicle communication systems also include radio, cellular (wireless) phones, and location beacons. Two-way radios are used between a bus operator and a central dispatch system. Cellular phones sometimes provide more flexibility and require less centralization. On-board location beacons work with on board communication systems to provide other information about vehicles (see Automatic Vehicle Location section below)

Figure B-1: Relationship of ITS Technologies



3.2 Annunciators (Talking Vehicles)/In-Vehicle Information Displays

Annunciators provide verbal instructions and information to passengers on transit vehicles. As applied in automated systems such as airport people movers or on light rail systems, annunciators tell passengers which stop they are departing from and which stop they are approaching. In the natural settings of federally-managed lands, annunciators are being used to provide interpretation between stops in addition to helping passengers use the system itself. Annunciators are also used to provide comprehensive services for sight-impaired people and/or people unfamiliar with an area that may need to navigate by landmarks rather than street intersections.

In-vehicle information displays (see Figure B-2) function much the same way as annunciators, but provide visual cues and information rather than audio information. Often the two technologies are provided in tandem to maximize the visitor experience.

Figure B-2: In-Vehicle Information Displays

3.3 Computerized Dispatching/Scheduling/Ridematching Systems

Traditionally, scheduling software was used only for the preparation of driver assignments on specific routes and runs. It was done in advance with little ability to correct assignments on-demand. With the integration of ITS technologies, these computer systems are able to do the following:

- Make driver assignment and schedule changes on-demand and in real time,
- Accept data about actual performance versus expected performance and adjust scheduling,
- Accept advanced trip reservations for demand-responsive services.
- Assign trip requests to shared-ride vehicles with or without human intervention.

3.4 Automatic Passenger Counters

Automatic Passenger Counters (APC) provide automatic collection of passenger boarding and alighting information by bus stop or route segment by trip, time period, or day. Depending on the type of service, vehicle deployment strategy, and data needs, it might not be necessary to equip all revenue vehicles with APC technology. A number of transit systems equip only as many “data buses” as are required to survey the entire system by route or service sub-area over a period of time. APC technology offers the ability to

collect accurate information concerning utilization of transit services and performs random trip sampling as required by Section 15 of the Federal Government Code. Often APC data is provided as input to the computer dispatching/scheduling/ridematching mentioned above. APC's can, but are not required to be compatible with smart card technologies. For more on smart cards, refer to Section 4.0.

3.5 Automatic Vehicle Location

Automatic Vehicle Location (AVL) Systems provide a dispatch center the capability to monitor the location of all vehicles continuously in real time. AVL is usually integrated with digital communications and Geographic Information System (GIS) mapping systems to streamline instructions from the dispatcher who is able to view vehicle itineraries and locations graphically. Each driver has a Mobile Data Terminal (MDT) in the vehicle that allows extensive planning information to be collected at a lower cost than by manual methods (i.e. schedule adherence, location-based passenger counts, and location-based fare collection information).

AVL technology has a significant positive effect on transit service quality, productivity, and customer satisfaction, including:

- Monitoring schedule adherence and minimizing the impacts of schedule delays on passengers.
- Coordinating passenger transfers between modes.
- Maximizing the productive use of capacity created by last minute cancellations, no-shows and unanticipated time savings in scheduled vehicle tours.

The equipment installed on-board each transit vehicle should consist of the MDT, a Vehicle Logic Unit (VLU) vehicle location sensor equipment and radio interface electronics and controls. In addition, a wide variety of additional devices could be interfaced to the AVL system via the VLU in the future. Some of the additional devices which the system design should be able to accommodate include silent emergency alarms, passenger counting equipment, engine monitoring and diagnostic equipment, door sensors, wheelchair lifts, fare boxes, traffic signal preemption devices, overhead sign control equipment and automatic audio and visual passenger information devices.

The VLU is the central processing and interface device on the transit vehicle. This device receives vehicle location data from the automatic location equipment and constantly compares the vehicle's location with the scheduled location. Any deviations beyond defined thresholds are indicated to the bus operator and reported back to the central dispatch system. The VLU is also responsible for recording data downloaded from the central dispatch system. The data recorded by the vehicle and uploaded to the system may be passed to other systems so that the data can be used to properly analyze the transit vehicle's operation and to improve the schedules and operational efficiency of the transit service.

These technologies are relatively mature and reliable for computerized scheduling and dispatching. A similar conclusion can be made for shuttle systems that are dominated by pre-ordered trips.

4.0 ITS SMART TRAVELER TECHNOLOGIES APPLICABLE TO FEDERALLY-MANAGED LANDS

This section focuses on the specific ITS applications most relevant to and usable by visitors in the natural settings of federally-managed lands. Smart traveler systems provide transportation system users with access to accurate, real-time information to make convenient travel decisions. Much of the technology

necessary to support smart traveler systems is provided by the smart vehicle systems described earlier in Section 3.0.

Possible technologies that provide traveler information include:

- Web sites.
- Passenger Information Displays (Smart Kiosks).
- On-board Information Displays.
- Personal Wireless Devices.
- Automated Fare Collection (Smart Cards and Magnetic Strip Cards).

Figure B-3: Smart Kiosk

4.1 Websites

Computer-based web sites allow visitors (travelers) to get pre-trip information. Web sites are capable of providing static and real-time information. Static information includes such things as schedules, route maps, and system maps. Real-time information, depending on the sophistication of the system, could include information about the actual location or schedule adherence of a service compared to the static schedule, weather updates, and road or parking information.

4.2 Passenger Information Displays (Smart Kiosks)

Passenger information displays or (smart) kiosks (see Figure B-3) are the equivalent of a public website connection to transportation information. The advantage of the kiosk over the website is that the visitor to federal lands would not have to carry a computer with them to access the information. Kiosks can be placed at the entrance gate of federal land site or in each of that site's activity centers. For visitors arriving from outside the federal land site, similar kiosks can be stationed at nearby airports, in gateway communities, at regional visitor centers, and at state highway welcome centers.

4.3 Personal Wireless Devices

Personal wireless devices, including phones, internet access, the radio, pagers, and "palm pilot" type devices are all means of providing visitor information. Highway Advisory Radio (HAR) and other radio-based information sources have been in use in federal land sites for years. Communication capabilities are being increased such that it is now or will soon be possible to receive a page or a phone call from the bus to inform the visitor/passenger that that service will be arriving within several minutes.

In connection with the GPS and AVL systems mentioned in the previous section, information can also be transmitted to fixed signs. Signs placed in terminals or at bus stops can then display real-time information for passengers.

4.4 Automated Fare Collection (Smart Cards and Magnetic Strip Cards)

A smart card is a highly tamper-resistant chip and an integral operating system. The operating system provides the commands, data access, and security controls. The smart card must be inserted in a reader/writer machine that supplies power to the chip and the connection for communication. The card is reusable but expensive. Magnetic strip cards are a less expensive option, and provide some (but not all) of the same benefits as smart cards, including storing monetary (fare) information. Magnetic strip technology is available in disposable paper form as well.

In transit applications, smart cards combine secure, cash-less transactions and personalized applications. These also provide transit authorities with the demographic information needed to meet government reporting requirements and to market to target groups. In the transit environment, smart cards can be used as debit, credit or stored-value cards. For the natural settings of federal lands, these cards could provide a convenient means of fare payment for patrons using on-site transit service repeatedly over a period of several days. Ultimately, the use of the cards could be integrated into payment systems for other services.

5.0 SUMMARY AND CONCLUSIONS

Collectively, as ITS technologies are more fully integrated into the federal land setting, they will provide information on the status of a transportation system and will be useful in managing an entire transportation system (all modes) in a manner not previously possible. ITS technologies will increase both the quantity and quality of information, as well as provide the ability to respond to transportation system dynamics in a real-time fashion. Such ITS technologies will allow federal land managers and visitors to take advantage of opportunities (surplus capacity) and respond to problems (congestion, incidents, etc.) as they happen. It will allow federal land sites to better adjust other visitor management tools (ticketing, fees, etc.) and services (interpretation, concessions, etc.) congruent with the transportation system performance. It will also allow federal lands to provide additional travel/tour information at a distance to visitors arriving from gateway communities (especially rural locations), nearby airports or bus terminals, and other facilities.

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